Notes on some Points connected with the Progress of Astronomy during the Past Year.

Discovery of Minor Planets in 1904.

Fifty-nine new planets were discovered, or first announced, in 1904 as follows :—

Letter and Number.	Date of Discovery.	Discoverer.
MY ...	1904 Jan. 10	Dugan
NB 521	„ „ 10	„
NC 522	„ „ 10	Wolf
ND 523	„ „ 27	Dugan
NE ...	1903 Nov. 26	Hirayama
NF ...	„ Dec. 15	Peters
NG ...	„ Oct. 27	Götz, Wolf
NJ ...	1904 Mar. 4	Wolf
NK ...	1901 Jan. 17	„
NL ...	„ May 9	„
NM ...	1902 Oct. 8	Götz
NN 524	1904 Mar. 14	Wolf
NO 525	„ „ 14	„
NQ 526	„ „ 14	„
NR 527	„ „ 20	„
NS 528	„ „ 20	„
NT 529	„ „ 20	„
NU ...	1902 „ 10	„
NV 530	1904 Apr. 11	„
NW 531	„ „ 12	„
NX ...	„ „ 16	„
NY 532	„ „ 20	„
NZ 533	„ „ 19	Dugan
OA 534	„ „ 19	„
OB ...	„ „ 21	Wolf
OC 535	1904 May 7	Dugan
OD ...	„ „ 11	„
OE ...	„ „ 13	Wolf
OF 536	„ „ 11	Peters
OG 537	„ July 7	Charlois
OH ...	1903 Apr. 28	Peters
OJ ...	„ June 29	„
OK 538	1904 July 18	Götz
OL 539	„ Aug. 2	Wolf
ON 540	„ „ 3	„
OO 541	„ „ 4	„
OP ...	„ „ 14	„
OQ 542	„ „ 15	Götz, Kopff
OR ...	„ Sept. 6	Kopff
OS ...	„ „ 5	„
OT 543	„ „ 11	Götz
OU 544	„ „ 11	„
OV ...	„ „ 11	Kopff
OX ...	„ „ 19	„
OY 545	„ Oct. 3	Götz
OZ ...	„ „ 9	Wolf
PA 546	„ „ 10	Götz
PB 547	„ „ 14	„
PC 548	„ „ 14	„
PD ...	„ „ 15	„

Letter and Number.	Date of Discovery.	Discoverer.	Letter and Number.	Date of Discovery.	Discoverer.
PF ...	1904 Oct. 16	Wolf	PM 551	1904 Oct. 16	Wolf
PG ...	,, ,, 13	,,	PN ...	,, Dec. 14	,,
PI ...	,, ,, 15	,,	PO 552	,, Nov. 16	,,
PK 549	,, ,, 15	,,	PP 553	,, Dec. 14	,,
PL 550	,, ,, 16	,,			

NE was discovered at Tokio; NF, OF, OH, OJ at Washington; OG at Nice; the remainder at Heidelberg.

The following planets, unnumbered at the date of the last report, have since received permanent numbers: LY 513, MB 514, ME 515, MG 516, MH 517, MO 518, MP 519, MV 520, PK 549, PL 550, PM 551, PO 552, PP 553.

The following planets do not receive permanent numbers, not having been sufficiently observed: LW, LX, LZ, MC, MD, MF, MK, MM, MN, MQ, MR, MS, MT, MU, MW, MX, MY, NE, NF, NG, NJ, NK, NL, NM, NU, NX, OB, OD, OE, OH, OJ, OP, OR, OS, OV, OX, OZ.

The following identities have been established: MZ with 409 *Aspasia*, NA with 505, NH with 200 *Dynamene*, NP with 255 *Oppavia*, OM with 236 *Honoria*, OW with 485, PE with 178 *Belisana*. The following identities are probable: OH with 353 *Ruperto-Carola*, OJ with 411, PH with 157 *Deianira*, one of the long-lost planets.

The following identities were at first suspected but negatived: NF with DW, MV with 316 *Goberta*, MY with MP, NJ with 310 *Margarita*.

The following planets have been named: 394 *Arduina*, 460 *Scania*, 496 *Gryphia*, 498 *Tokio*, 499 *Venusia*, 509 *Jolanda*, 512 *Taurinensis*, 516 *Amherstia*, 521 *Brixia*, 532 *Herculina*.

NF seems to have a very eccentric orbit, the value 0·4 being found for the eccentricity; NW was moving north at the unusual rate of 23′ daily; NY (*Herculina*) was of magnitude 9·0 at discovery, which is unusually bright for a modern discovery; NM must have been near DW in 1902, but is not identical with it; NK, NL may be a single planet, in which case it would have an interesting orbit.

433 *Eros* will be in opposition early next August in south declination 13°: its magnitude will be 11·2, the circumstances being similar to those at discovery in 1898. The *Jahrbuch* for 1907 contains an ephemeris.

Popular Astronomy for December 1904 contains an article by Mr. B. L. Newkirk on the twenty-two asteroids discovered and endowed by the late Professor Watson. The study of their orbits has been undertaken by the Berkeley Observatory under the supervision of Professor Leuschner, and it is stated that with the exception of the missing planet, 132 *Æthra*, the work is in a forward state. It is conjectured that the orbit of

132 *Æthra* has been completely altered by the action of *Mars*, and Miss Hobe is shortly going to attempt to deduce the present orbit. It is, however, difficult to see how *Æthra* could ever approach near enough to *Mars* to suffer large perturbations unless the accepted elements of the former are utterly erroneous; for, according to these, the latitudes of the planets are widely different at the point of approach. However, all will hope that the researches may lead to the recovery of the planet, whose orbit is interesting from its large eccentricity and from the fact that its period is almost exactly one-third of *Jupiter's*.

The orbits of planets 505, 521 approach each other within about one-third of a million miles, and the planets actually made a close approach to each other in 1903 November. It is not, however, probable that their mass is great enough to cause any sensible perturbations even at that small distance.

A. C. D. C.

Saturn's Ninth Satellite, Phœbe.

The discovery of *Phœbe* was first announced in 1899 from photographs taken in Arequipa in 1898, but its complete confirmation can only be said to date from 1904. A long period of silence followed the first announcement, which, as Professor W. H. Pickering explains, was due partly to his attention being called off by his photographic work on the Moon and partly to the fact that *Phœbe's* orbit has an unexpectedly large eccentricity, which made its apparent distance from *Saturn* in 1900 much greater than was anticipated, so that it remained undetected for a time. At length the idea occurred to him to extend the region of search on the plates, and his perseverance was rewarded by the detection of several images of the satellite.

It was found possible to construct a direct orbit which would represent the positions of 1898 and 1900 without large errors. However, when search was made on the plates taken at Arequipa in the spring of 1904 no trace of *Phœbe* could be found in the calculated position, but it was at length found a considerable distance away. Two hypotheses were now possible: (1) the object photographed in 1904 was not the same as that recorded in the earlier years; or (2) if the same object, it must be moving round *Saturn* in the opposite direction to that of all the other satellites of that planet. The latter was such an unexpected result that it was not received without hesitation. However, on examination so many lines of evidence converge to establish it that there can be little doubt of its reality: (1) viewing the orbit as a circle and neglecting the eccentricity, the change in the pose of the apparent ellipse in the different years is in accord with the retrograde hypothesis, and with that only; (2) taking the eccentricity into account, the position of the *perisaturnium* in the different years led to the same result; (3) a third line of

evidence, not in itself convincing, but adding weight to the others, is that the observations since 1898 appear to show a *direct* motion of the node of the orbit, which would imply that the satellite moves in the opposite direction. As to the suggestion of two different satellites, it seems enough to say that the possibility of satisfying all the positions from 1898 to 1904 (except a few which had been already noted as doubtful, from their extreme faintness) by a single orbit renders very improbable the hypothesis of two different orbits related to each other in such an extraordinary manner.

Professor Berberich makes the curious suggestion in *Ast. Nach.* 3988 that the object seen in 1904 may not be a satellite of *Saturn* at all, but an asteroid whose orbit lies near *Saturn's*. This would be a reasonable suggestion if we had only a few isolated observations last year; but considering that there is a continuous series extending from April 16 to November 10, made with three different instruments—the Bruce reflector at Arequipa, the Yerkes refractor, and the Crossley reflector at Mount Hamilton—and that all the positions are in satisfactory accord with the hypothesis of elliptical motion round *Saturn*, Professor Berberich's suggestion seems quite untenable.

A perfect agreement with elliptical motion is not to be expected, for, as Professor Newcomb and others have pointed out, the solar perturbations of *Phœbe* must be very large; in particular, the evection coefficient is about $4°$, which would produce a shift of over $2'$ in its geocentric position. Newcomb estimates that the apse would have a retrograde movement of between $\frac{1}{2}°$ and $1°$ annually, so that this should be sensible in a few years, especially as the eccentricity of *Phœbe's* orbit is so large (about 0·22, nearly double that of *Hyperion*, which had the most eccentric orbit of any satellite previously known).

The period of *Phœbe* is 547 days, or $1\frac{1}{2}$ year; its distance from *Saturn* 0·0862 in astronomical units, or 8 millions of miles. Its magnitude in opposition is probably between 15 and 16, from which its diameter is estimated as about 150 miles. Seen from *Saturn*, it would only appear as a star of the fifth or sixth magnitude, and would have a disc of about $4''$ in diameter!

One explanation given of the retrograde motion is that the satellite is not an original member of the Saturnian system, but was captured later. Professor W. H. Pickering makes an alternative suggestion—viz. that originally *Saturn* rotated backwards, and that *Phœbe* was born at this period, while solar tides turned the planet over before the other satellites were born. Others had already pointed out that if the planets were formed from nebulous rings the inner portions would move quickest round the Sun, and a retrograde rotation would result. But the suggested action of the solar tides does not seem to have yet been verified mathematically, and till this is done the theory should be received with caution.

Within the last few days the announcement has been received

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of the discovery of a similar very distant satellite of *Jupiter*. The search for this was doubtless suggested by the discovery of *Phœbe*. If its existence is confirmed, and if its motion round *Jupiter* should prove to be retrograde, it will undoubtedly lend an air of verisimilitude to Professor Pickering's hypothesis; but if direct, it will seriously discount it.

In any case, the discovery of *Phœbe* excites our admiration as a great optical triumph and adds a new and unexpected feature to the solar system. A. C. D. C.

The Comets of 1904.

The following comets have been discovered during the year:—

Brooks's Periodical Comet of 1889, V., seen at the Lick Observatory on 1903 August 20, and followed at the Washington Observatory till 1904 February 15.

Comet *a*, 1904, discovered by Mr. Brooks, of Geneva, U.S.A., on April 16. Particular interest attaches to this discovery, since the examination of plates taken previous to the announcement disclosed earlier positions. Both Professor Pickering at Harvard and M. Rudaux at Domville had secured places. The comet was very generally observed throughout the summer and autumn. The orbit is apparently parabolic and distinguished by the large perihelion distance of 2·7 R.

Encke's Comet, first traced on a photographic plate taken at the Heidelberg Observatory with an exposure of three and a half hours on September 11. The comet was not generally observed till the end of October; but the circumstances were favourable for observers in the Northern Hemisphere, and throughout November and December many observations were secured. Towards the end of the latter month the comet was too close to the Sun for observation. The comet makes a close approach to *Mercury* at this return.

Tempel's Second Comet (1873 II.) was found by M. Javelle at Nice on November 30. The ephemeris to assist discovery was prepared by MM. Schulhof and Corniel, and represents the path of the comet with considerable exactness. The object is visible in the evening sky, being near *Venus*; but though the position may become slightly more favourable the brilliancy is decreasing.

On December 17 M. Giacobini, of Nice, detected a new comet which is still being observed. The comet is at a great distance both from the Sun and the Earth, so that the brilliancy alters slowly; but since the object has considerable north declination it is likely to be observed for some time.

On December 30 M. Borrelly, of Marseilles, found a telescopic comet which, like the preceding, is still under observation. On the form of the orbit it is premature to pronounce an opinion. The comet is near the equator, moving north, and diminishing in brightness.

The comets known as D'Arrest and Winnecke passed through perihelion without being seen.

Definitive orbits of the following comets have been published during the year :—

Comet.	Character of Orbit.	Calculator.	Authority.
1845 III.	Elliptical	Peck	*Ast. Jour.* vol. xxiv.
1887 II.	Elliptical	Stechert	*Ast. Nach.* No. 3957
1889 IV.	Elliptical	Horn	*Denksch. Wien. Ak.* 74
1890 III.	Parabolic	Rheden	*Sitz. Wien. Ak.* 113.
1898 X.	Elliptical	Scharbe	*Ast. Nach.* vol. clxiv.

Professor Lane Poor, continuing his researches on Brooks's Periodic Comet of 1889, 1896, 1903, has concluded that it is not identical with Lexell's Comet of 1780. W. E. P.

Progress of Meteoric Astronomy in 1904.

Quadrantids.—Very cloudy weather veiled this shower. On January 3, $12^h\ 30^m$ to $13^h\ 25^m$ G.M.T., Mr. Henry, of Dublin, counted 17 meteors, eight of which were at least equal to first-magnitude stars.

Lyrids.—Overcast skies also affected the visible return of these meteors, and few of them were seen.

Perseids.—This display was very fully and satisfactorily observed. From the whole of the reports the meteors appear to have been a little more abundant than usual, with a maximum on the morning of August 12.

Professors Perrotin and Maynard observed the shower from the summit of Mount Mounier, and on the five nights August 9–13 counted 1184 meteors, of which 941 were *Perseids.* Maximum between 13^h and 16^h August 11, horary number 92, chief radiant near γ *Persei.*

Mr. W. Wetherbee, of Barre, N.Y., on August 11, in less than 3^h, counted 154 meteors, including 116 *Perseids.*

Mr. P. M. Ryves, of Uxbridge, on August 11, between $9^h\ 45^m$ and $13^h\ 45^m$, observed 160 meteors, including 99 *Perseids.*

M. Lucien Libert, at Havre, on August 11 to 20 saw 339 meteors, and noted the motion of the *Perseid* radiant very distinctly between August 11 and 16.

Mr. A. King, Leicester, on August 11, between $10^h\ 17^m$ and $14^h\ 20^m$, observed more than 105 meteors, of which more than 80 were *Perseids.* At end of watch the horary rate was 53 and increasing. He regarded the shower as fairly rich and traced the easterly drift of the radiant.

MM. Biesbroeck and Philippot, in Belgium, on August 10 to 13 observed a great number of *Perseids* and other meteors, and derived the mean radiant at $45^\circ{\cdot}34+56^\circ{\cdot}47$. The comparative figures for the orbit of the meteors and of Tuttle's Comet 1862 III. were computed as follow :—

Perseids.		Comet 1862 III.	
	° ′		° ′
π =	291 59	π	290 48
☊ =	138 51	☊	138 2
i	115 11	i	113 34
q	0·966	q	0·963

Mr. Denning, at Bristol, on August 11 and 12 thought the display weaker than usual ; but the observations were incomplete and the weather not favourable.

The shower was watched at a great many other stations, the atmospheric conditions being suitable and the sky moonless.

Orionids.—These meteors were well seen on October 18 at the University of Virginia, U.S.A. Mr. C. P. Olivier and two other observers noted 115 meteors, including 75 *Orionids*, in a watch of about five hours, and the mean place of the radiant was at $92^\circ+16^\circ$. The shower was not quite so numerous as usual, and was remarkable for the general smallness of the meteors.

Leonids.—This shower returned with moderate activity on the morning of November 15, and was widely observed, the weather at about this period being very fine, though fogs were prevalent at times. The maximum occurred on November 14, between 16^h and 19^h G.M.T., and probably nearer the earlier hour, but it is difficult to define it exactly. At Greenwich, Meltham, near Huddersfield (C. L. Brook), and Charmouth the maximum seemed to have been indicated between 16^h and $16^h\ 15^m$, but at Harvard College Observatory the numbers rapidly increased until in the 9 min. preceding 14^h (G.M.T. 19^h), with three observers, the meteors were coming at the hourly rate of 134, after which the shower exhibited a marked decrease in intensity. In England the rate of apparition seems to have increased from about 10 *Leonids* per hour (one observer) at midnight to 25 per hour at about 14^h, and to 60 or 70 per hour at about 16^h. But it is certain from many observations at home and abroad that during the next three hours (up to 19^h) the *Leonids* continued very numerous and included many brilliant objects, though the meteors generally do not seem to have equalled the average brightness of those seen on 1903 November 15.

The following are a few extracts from individual observations :

At Greenwich fog began to obscure the sky after $16\frac{1}{2}^h$ November 14, so that though the maximum number of meteors was observed between $16^h\ 5^m$ and $16^h\ 10^m$ the greatest intensity of the shower may really have occurred later.

Mr. C. L. Brook, near Huddersfield, on November 14, 16^h to 18^m, counted 69 *Leonids*, of which 17 appeared in the first quarter of an hour of the watch.

Mrs. Arthur Brook at Charmouth, on November 14, 12^h to $17^h\ 30^m$, observed 144 meteors, of which about 115 were *Leonids*, and the maximum occurred between $15^h\ 50^m$ and $16^h\ 20^m$, when the rate was at least one per minute.

Mr. W. H. Pickering, at Harvard, U.S.A., reports that on November 14 three observers saw 275 meteors, including 183 *Leonids.* At about midnight the horary rate was 15 : this had risen to 134 just before 14^h, and was about 40 until 15^h, after which it was 27 for one observer. The times are Eastern Standard, and are 5^h slow on G.M.T. Only one *Leonid* was photographed at Harvard, whence Mr. Pickering concludes that only very bright or very slow meteors are capable of making an impression on the plates.

At the University of Illinois the following numbers were counted by Mr. J. Stebbins :—

	h m		h m		Leonids.	Other Meteors.
Nov. 13	13 5	to	17 5	C.S.T.	18	21
14	13 0	„	17 0	„	44	42
15	12 50	„	17 0	„	23	20

Very few *Leonids* were seen anywhere on the nights following November 13 and 15, and the maximum, such as it was, decidedly occurred on November 14 ; but it was not more than one-fourth the richness of the *Leonid* shower of 1903. The recent display is, however, very interesting, for the parent comet (Tempel 1866 I.) passed through perihelion in 1899. There were pretty abundant displays in 1838 and 1871, five years after the brilliant maxima in 1833 and 1866, and the *Leonids* of 1904 probably represented a return of the same group.

Andromedids.—The Rev. W. F. A. Ellison, of Enniscorthy, observed what appears to have been a well-marked return of the *Andromedids* on November 21. At 7 P.M., though the Moon was nearly full, he saw 8 meteors in 15 seconds, and during the hour from 7^h to 8^h there were 24 altogether, and from 8^h to 9^h 22 more, but few afterwards on the same night, though meteors from the same radiant continued to fall until November 28. The radiant was at about $21° + 50°$.

Geminids.—Mr. A. Sullivan, Dundrum, Dublin, observed this shower on the night of December 12, when between $10^h\ 17^m$ and $11^h\ 15^m$ G.M.T. he counted 20 *Geminids.*

The following is a list of the real paths of several bright meteors observed in England during the past year :—

Date.	G.M.T.	Brightness.	Height at First. Miles.	Height at End. Miles.	Length of Path. Miles.	Velocity per Sec. Miles.	Radiant Point. α δ	Observers.
1904.	h m						° °	
Jan. 9	8 28	♃ − > ♃	60	41	27	6	41 + 5	2
10	8 33	♀ − > ♀	67	31	43	21	43 + 22	2
15	9 22	♀	63	27	36	12	*61 + 41	2
June 20	9 56	♀	66	42	42	...	*302 + 23	2
Aug. 11	10 39	1 − ♀	75	56	33	35	46 + 58	2
Sept. 18	12 10	> ♃	58	23	54	21	13 + 7	2
Oct. 8	7 0½	= ♃	66	25	82	10	260 + 4	3
Nov. 3	10 55	2½ × ♀	70	23	73	14	344 + 24	6
14	16 25	> ♃	88	44	59	46	151 + 22	3
15	14 40	{3½ × ♀ / − = ☽}	86	40	88	...	*31 + 20	5
Dec. 18	4 38	= ♀	81	30	64	32	*337 + 60	6
22	4 30	...	83	28	58	29	*330 + 36	6

A Low Perseid.—On August 12 Herr P. Götz, of Heidelberg, photographed, with two Voigtländer objectives near together, the trail of what appears to be a very low *Perseid*, the height varying from three to nine miles. But the parallax was too small for the deduction of accurate results, for the average heights of the *Perseids* are from 80 to 54 miles, and of the *Leonids* from 84 to 57 miles. The *Perseids*, *Orionids*, *Leonids*, and other meteors of the swift, streaking type very rarely if ever penetrate our atmosphere sufficiently deep to get within 40 miles of the Earth's surface.

Meteorite of 1903 *January* 3.—A meteorite is stated to have fallen at 11^{h} 30^{m} P.M. at St. Mark's, Kaffraria, S. Africa. It gave a great glare of light, and four loud explosions accompanied its descent. The meteorite appears to have broken into two, one fragment of which fell obliquely in a field, making a hole two feet deep and being found on the further edge of it. The stone is black, slightly fused on the surface, and on one side are a great number of lines radiating from the centre. Its weight is 30½ lb.

W. F. D.

Total Solar Eclipses.

1904 *September* 9.

The central line of the eclipse of 1904 September 9 was confined to the Pacific Ocean. No observation of it was made.

* Radiant points not precisely determinable from the incomplete or discordant character of the observations.

1905 *August* 30.

The eclipse of 1905 August 30, with a path traversing Labrador, Spain, Algeria, Tunis, and Egypt, is of considerable importance owing to the fact that it is the last that will be visible from any readily accessible parts of the Earth's surface for many years. For this reason it is hoped that adequate arrangements will be made for its observation at various places along the central line.

It is also notable owing to the long interval of time—$2\frac{1}{2}$ hours—between totality at points situated towards the extreme ends of the path in Labrador and Egypt. Large scale photographs taken at the western and eastern stations should throw light upon the vexed question of the rate of change in shape of the coronal rays and streamers.

It will be remembered that in 1893, when there was a gap of $1\frac{1}{2}$ hour between totality in Brazil and in West Africa, an examination of the photographs taken with similar instruments disclosed no perceptible change of form.

Since then there has been no eclipse where pictures separated by any substantial interval of time have been secured. Moreover, on this occasion it is expected that instruments of considerable focal length will be used both in North America and in Egypt, so that the comparison of their resulting images cannot fail to be interesting.

The Joint Permanent Eclipse Committee are arranging to send five parties of observers, who will occupy stations in Spain, Algeria, and Egypt; and it is hoped that the Royal Observatory, Greenwich, will send a party to Algeria.

The proposed observations comprise an extensive programme of spectroscopic work, both with slit spectroscopes and with objective prisms of long focus and of dispersion considerably greater than have been before employed; of polariscopic work with Iceland spar prism; of determinations of the coronal radiation with a bolometer; of photographs of the corona with instruments of long and short focus, and other work.

In addition to the official parties there will doubtless be a large number of observers sent out under the auspices of the British Astronomical Association and other bodies. The facility of the journey to Spain and the fact that the eclipse falls in the summer vacation will render it easy for astronomers to take this opportunity of viewing a phenomenon which will not recur, under such favourable conditions as regards accessibility, for nearly a decade. E. H. H.

Solar Activity in 1904.

Sun-spots.—The character of the sun-spot record for 1904 may be very briefly summarised. There has been a slow, steady increase in the numbers and areas of spots without any striking incidents. There have been no days upon which the Sun has been observed to be free from spots; there have been no spot-groups of the first rank of importance. No single month has shown anything like the activity observed in 1903 October; no single group has approached that of 1903 October 5–17 in area. But there has been a slight but steady progress throughout the year, so that the mean daily area for the year is a little above that for 1903; the figures will probably work out as about 470 millionths of the Sun's visible hemisphere, as against 339 for 1903. This indicates an exceptionally slow advance; an area of at least 1000 might have been expected so long after the minimum if the precedent of the two preceding cycles had been followed.

Faculæ have behaved much in the same way as sun-spots; that is, they have shown a steady, persistent, but slow increase without any very striking incidents. But their rate of increase has been less slow than that of the spots, and their mean daily area for 1904 will not come very far short of doubling that for 1903, or will be about 1700 millionths as compared with 969.

The mean latitude of sun-spots has undergone but little change during the year; but the higher-latitude spots have been dying out, and two or three small spot-groups have been seen within 10° of the equator.

The most important groups of the year appeared in April, and ran their courses from April 9 to April 20, and April 21 to May 2.

E. W. M.

The Prominences.—The year 1904 has proved very favourable for observation, and 127 complete drawings of the solar profile have been obtained at Kenley. The mean daily number of prominences again shows a marked increase, the general activity for the year being nearly twice that of 1902—a year of minimum activity.

The mean numbers for the two hemispheres derived from observations on 88 days in 1903 and 127 days in 1904 are as follows:—

	1903.	1904.
North hemisphere	3·64	4·92
South „	3·91	5·14
Total mean number per diem ...	7·55	10·06

Dividing the year into two periods of six months, the increase is found to be progressive, the total mean numbers

being 9·0 per diem for the first half and 11·0 per diem for the second half. The total increase of 33 per cent. shown by the above figures does not, however, apply to all latitudes where prominences occur, but is chiefly confined to the equatorial zone and a zone in mid-latitudes between 30° and 40°; these zones have increased in a much greater ratio, whilst some regions in the Northern Hemisphere have actually decreased in activity.

Part of the general increase may be attributed to an advance towards the poles of the high-latitude prominences, which have thereby *reclaimed* a considerable area of the barren polar regions. These prominences now occupy the zones +55° to +65° and −55° to −70°, and these zones are still the most active regions on the Sun.

The general order of change in the prominence distribution as the sun-spot maximum is approached appears to be characterised by a great welling up of prominences in mid-latitudes, followed by an increase in the latitude of the high-latitude prominences, which seem forced by their rivals in lower latitudes to take up positions nearer to the poles. The present distribution conforms more nearly to that of 1892 than any other year since 1889.

Metallic prominences were very infrequent during the first half of the year, but later they increased considerably and reached a maximum frequency in September. On the 20th of that month the magnesium lines were strongly reversed in the upper chromosphere at almost all positions on the limb—a very unusual occurrence.

Many of the metallic prominences observed appear to be recurrences after one or more half-rotations; thus the following sequences have been observed :—

	Date.	Limb.	Latitude.	Longitude.	Period.
(1)	June 27	E	+44	285	3 rotations 27·83 days.
	Sept. 18	E	+44	267	
	19	E	+43	254	
(2)	June 27	W	−32 to −46	105	3 rotations 27·67 days.
	Sept. 18	W	−30 to −39	87	
(3)	June 29	E	−23	258	5 rotations Mean period 27·20 days.
	Sept. 4	W	−22	272	
	21	E	−22	228	
	Nov. 12	E	−24	262	

The decrease in rotation-period with decreasing latitude is here clearly indicated.

J. E.

A Comparison of the Features of the Earth and the Moon.

Professor N. S. Shaler, of Harvard, who commenced to study the Moon in 1867 with the Harvard 15-inch Merz refractor, has recently published in No. 1438 of the *Smithsonian Contributions to Knowledge* his views as a geologist on the processes by which the surface of our satellite has been moulded. He finds a continuous gradation from the largest to the smallest of the ring mountains, and classes them all as "vulcanoids," believing them to have been formed by a non-explosive ebullition of lava. He rejects the theory that the rise and fall of the lava was due to earth-raised tides, and also the theory that the vulcanoids were formed by the impact of meteorites. He, however, adopts the view that the maria were formed by the impact of bolides from five to ten miles in diameter as the only working hypothesis which in any way accounts for the phenomena. The principal mountain ranges are supposed to have been formed by the exudation of very viscid lava, sometimes, as in the Altai range, brought about by faulting. The low ridges on the maria are caused by the action of pressure in the crust. Valleys of the Alpine type are attributed to double faulting; the rills to cracks in the surface, formed at so late a period that they failed to reach a fluid stratum; the bright ray systems to incipient cracks through which vapours, condensing to crystalline material, have issued.

Professor Shaler will not admit the existence of any lunar atmosphere or any form of organic life, and he believes that the surface of the Moon was brought to its present condition before the Earth had even a solid crust. S. A. S.

Double Stars.

To make this report continuous the work has been classified under the two heads "Observation" and "Calculation," as in previous years. Abbreviated titles have been used as follows:—

M. N.: Monthly Notices R.A.S.
A. J.: Astronomical Journal.
L. O. B.: Lick Observatory Bulletin.
A. N.: Astronomische Nachrichten.

Observations—

R. T. A. Innes. M. N. lxiv. 2, p. 130. Measures of 100 pairs with the 18-inch refractor at the Cape Observatory in 1903.

Rev. T. E. Espin. M. N. lxiv. 3, p. 238. A list of 15 new doubles with separation ranging from $2''\cdot7$ to $8''\cdot9$.

Rev. T. E. Espin. M. N. lxiv. 7, p. 675. Measures of 160 pairs with the $17\frac{1}{4}$-inch reflector. These are Σ, OΣ, and *h* stars, and were observed during 1900–4.

Royal Observatory, Greenwich. M. N. lxvi. 8, p. 789. Measures of double stars made with the 28-inch refractor in 1903. There are 280 pairs with separation under 2″ and 150 wider pairs which include *Sirius* and *Procyon*, and 110 Struve pairs requiring recent measures.

Miller and Cogshall. A. J., p. 554. A list of stars marked double in the Albany zone 1°–5° was formed, and 38 observed with the 12-inch refractor at Kenwood.

S. W. Burnham. Decennial *Publications* of the University of Chicago. These are measures of about 600 pairs of Struve, Herschel, South, which have been neglected, and pairs discovered by various observers which do not appear to have been observed. In effect it goes far in the direction of collecting and observing the odds and ends of double stars. During the work, which was done with the 40-inch Chicago refractor, a few new pairs were found, bringing Prof. Burnham's numbers from β 1291 to β 1308.

W. J. Hussey. L. O. B. 57 and 65. Prof. Hussey has continued his systematic search for double stars, and in each of these *Bulletins* he gives 100 new pairs, so bringing his total discoveries to 800. Most of these are close and difficult, at least 30 per cent. being less than 0″·5 separation.

R. G. Aitken. L. O. B. 50, 61, and 66. These new doubles also are the result of systematic search with the 12-inch and 36-inch Lick refractors. They are similar in character to those found by Professor Hussey, at least 75 per cent. being under 2″ separation. The total number now reaches 900.

M. Biesbroeck, "Observations d'Étoiles doubles et Discussion des Mesures." These measures and their discussion are by M. Biesbroeck (Ingénieur des Ponts et Chaussées), who had the use of the 15-inch refractor at the Brussels (Uccle) Observatory. The measures of these 360 pairs were made in 1903 and 1904, and are of a high order. The complete work was done and published in eighteen months.

Calculation—

Under this heading come two papers dealing with proper motions. In the *A. S. P.* February Professor Comstock selects 67 double stars in which the proper motion of the principal component is known, and the relative motion is presumably rectilinear. This enables him to obtain proper motions for the 67 fainter comites, which he has utilised to obtain a value of the apex of the Sun's way—viz. 297° and +28°. The second paper is by Messrs. Furner and Storey in the *M. N.* 1904 March. The authors are endeavouring to find proper motions for a number of double stars, and then proceeding on the lines of Professor Comstock. Seventeen pairs are discussed and others are promised.

A. N. 3946. Herr Prey gives the masses of the components of 70 *Ophiuchi* as 0·32 and 1·28 time that of the Sun. This determination is from meridian observations, and it is to be noted

that the fainter companion has four times the mass of the brighter.

Orbits computed are—

A. N. 3955, Lohse —*Sirius*, period 50·38 years.
A. N. 3970, Doberck—*Castor*, „ 347± „
A. N. 3970, Doberck—*ζ Sagittarii*, „ 21·6 „

Miscellaneous Information—

M. N. lxiv. 6, Plate 13. Fowler—Spectrum of Σ 2140 (*α Herculis*).

A. S. P. 99. Some nine years since Belopolsky found the fainter companion of *Castor* to be a spectroscopic double with a period of three days. The Lick observers now find the brighter star is a spectroscopic double.

B. A. A. xiv. 7, p. 280. J. E. Gore has a note on *κ Pegasi*, for which he gives the hypothetical parallax as ″0·106.

M. N. xlv. 2, p. 162. J. E. Gore discusses the relative brightness and hypothetical parallax of 48 binaries. He concludes that the relative brightness decreases regularly as the stellar type of spectrum moves from A to K, and at the same time the hypothetical parallax increases from ″·044 to ″·229.

Observatory, No. 347. Miss A. M. Clerke discusses seven nebulous double stars. T. L.

Variable Stars.

In reviewing the work done in this branch of astronomy during the past year one cannot but be struck with the very large number of new variable stars which has been added to those already known. From Harvard College Observatory, in circulars issued during 1904, no fewer than 407 new variables are announced. These have all been found by the method of examination of photographs, a method which ensures rapidity and accuracy. Of them, 90 are in the *Orion* nebula, including 10 discovered from photographs taken by the late Dr. Isaac Roberts; 57 are in the small Magellanic cloud, 152 in the large one, 105 are in *Scorpio*, and 16 in *Sagittarius*. In addition to these many variables have been found by other workers.

It would seem that a stage has now been reached when observation of *all* the known variables is impossible unless it were carried out under a far-reaching organisation.

Dr. S. C. Chandler has published in the *Astronomical Journal* (No. 553) a "Revision of Elements of Variable Stars" contained in his well-known third catalogue, and in No. 560 of the same periodical "Ephemerides of Long-period Variables from 1903 to 1910." Both these papers will be invaluable to workers in this branch.

An important study of the spectrum of *o Ceti* has been made at the Lick Observatory, from which it would appear that the variation is due to causes within the star, and not to a companion.

Herr Ludendorff's observations of *ε Aurigæ* indicate that the

Algol type of variation may extend to a period of many years, instead of being confined to a few days.

The publications of the observations of certain long-period variables made at the Rousdon Observatory, and inaugurated by the late Sir C. E. Peek, will be found in the *Memoirs* of this Society (vol. lv.). The material thus placed by Professor Turner at the disposal of anyone undertaking a research in this department is of great value on account of the excellence of the observations and the care with which they have been reduced.

E. E. M.

Stellar Spectroscopy in 1904.

Nebulæ.—Upon the spectroscopy of nebulæ little or no direct work has been published in 1904. Miss Clerke, however, contributes an interesting note to the *Observatory*, 1904, p. 303, on "Nebulous Double Stars," calling attention to stars involved in nebulæ.

Messrs. Frost and Adams (*Astroph. Jour.* xix. 352) have redetermined the radial velocity of the *Orion* nebula in the neighbourhood of the three brighter stars in the Trapezium; mean velocity from 11 plates +18·5 km/sec.

New Stars.—Perrine (*Lick Obs. Bulletin* 38, vol. ii. p. 130, and *Astroph. Jour.* xix. 80) describes observations made on various Novæ, and records the remarkable fact that the nebular line at λ 501 is no longer visible in Nova *Aurigæ*. Curtis (*ibid.*) records visual observations of Nova *Geminorum* and the conspicuous appearance of the green nebular line in its spectrum. Dr. Becker has published (*Trans. R.S. Edinburgh*, XLI. ii. No. 10) an account of his work on the spectrum of Nova *Persei* as photographed at Glasgow.

Classification of Stellar Spectra.—Sir Norman Lockyer, in discussing (*Proc. R.S.* **73**, 227) the "Temperature Classification of Stars," adduces new experimental evidence in the shape of photographs taken with a view of comparing the ultra-violet extensions of the spectra of various pairs of stars. The same writer has another note (*Proc. R.S.* **74**, 53) on the relation between the spectra of sun-spots and stars.

In a note read before the Section of Astrophysics at the St. Louis Congress (*Astroph. Jour.* xx. 342) Professor Frost calls attention to the desirability of arriving at some generally acceptable system of classification.

Distribution of Stellar Spectra.—The *Annals* of the Harvard College Observatory (vol. lvi. No. 1) contain a discussion of the celestial distribution of 32,197 stars according to their spectra. The work is being continued.

Studies of Special Stars.—Professor Pickering (Harv. Coll. Obs. *Circ.* 76, and *Astroph. Jour.* xix. 287) communicates a list of twenty-two stars having peculiar spectra.

R. H. Curtiss (*Astroph. Jour.* xx. 232) gives results (with photographic illustrations) of preliminary studies of the spectra of *R Scuti* and *W Cygni*; and also (*loc. cit.* p. 172) of *W Sagittarii* (Schmidt's variable γ' *Sagittarii*), with photographic illustration of the spectrum.

Professor Fowler (*Proc. R.S.* lxxiii. p. 219) claims to have identified the flutings in the spectra of stars of Secchi's Type III. ("dark flutings sharp towards the violet and fading off towards the red end of the spectrum"), with absorption corresponding to the bright flutings which he records for the first time as observed by him in the spark and arc spectra of titanium, and attributed by him to either titanium or titanium oxide.

Sir N. Lockyer and Mr. Baxandall (*Proc. R.S.* lxxiv. 255) give results of a study of enhanced lines of titanium, iron, and chromium with solar lines—"Fraunhoferic spectrum" as distinguished from chromospheric. The same writers (*Proc. R.S.* lxxiv. 296) give further reasons for regarding lines λ 4089·1, 4096·9, and 4116·1 (called by them Group IV. lines of silicium) as being rightly attributed to silicium; and they support their contention [in opposition to M. de Gramont (*C.R.* **139**, 188, and *Astroph. Jour.* xx. 233), who attributes them to air] by reference to stellar spectra, a photograph of ε *Orionis* being given in comparison with the bright lines evoked from a vacuum tube containing SiF_4.

Messrs. Haschek and Kostersitz (*Sitz. ber. Wiener Akad.* CXIII. vii.) discuss the origins of many lines in the spectra of γ *Cygni*, α *Canis Minoris*, and ϵ *Leonis.*

Father Sidgreaves (*Monthly Notices* R.A.S. lxiv. 168) gives further details about the spectrographic study of β *Lyræ*, and deals with it also in his interesting lecture at the Royal Institution (*Proc.* 1904 January 22).

Radial Velocity of Stars.—Mr. Belopolsky (*Astroph. Jour.* xix. 85) publishes results of his measurements relating to six "Standard Velocity Stars" in connexion with the co-operative scheme of observations:

α Persei	(1902·86)	$-2·89 \pm 0·4$	γ Aquilæ	(1902·91)	$-\ \ 1·98 \pm 0·4$
β Geminorum	(1903·16)	$+3·37 \pm 0·1$	ϵ Pegasi	(1903·24)	$+\ \ 5·99 \pm 0·2$
α Boötis	(1903·36)	$-6·07 \pm 0·4$	γ Cephei	(1903·68)	$-39·94 \pm 0·6$

Professor Lord (*Astroph. Jour.* xix. 246), in a paper dealing with possible variability in the velocity of η *Piscium*, gives his determinations of velocity for α *Cassiopeiæ*, α *Arietis*, ε *Pegasi*, ε *Leonis*, α *Ursæ Majoris*, α *Boötis*, ι *Aurigæ*, η *Boötis*, δ *Cephei.*

Mr. W. S. Adams (*Astroph. Jour.* xix. 338) has determined radial velocities of six stars in the *Pleiades*, and finds one of them, *Maia*, variable, whilst the remaining five have positive values between 3 and 15 km/sec.

Professor Küstner (*Ast. Nach.* **166**, 177) gives the radial velocities of eighteen stars in his account of the new spectrographic outfit at Bonn.

Messrs. Frost and Adams (publications Yerkes Obs. II. 143) have determined the radial velocities of twenty stars having spectra of the *Orion* type, and incidentally give the velocities of α *Arietis* −13·6, α *Tauri* +56·1, α *Boötis* −4·3.

Variable Radial Velocity.—The following stars have in the course of the year been found to exhibit signs of variable velocity in the line of sight :

	R.A. h m	Decl. ° ′	Mag. m		
α Andromedæ	0 3	+28 33	2·1	Lowell	Slipher, *Astroph. Jour.* xx. 146
η Piscium	1 26	+14 50	5·0	Emerson McMillin	Lord, *Astroph. Jour.* xix. 246
g Persei	1 56	+54 0	5·0	Yerkes	Frost and Adams, *Astroph. Jour.* xix. 152
20 Tauri (Maia)	3 40	+24 4	4·0	,,	W. S. Adams, *Astroph. Jour.* xix. 341
ε Persei	3 51	+39 43	3·0	,,	Frost and Adams, *Astroph. Jour.* xix. 152
θ_1 Orionis	5 30	− 5 29	4·8	,,	Frost and Adams, *Astroph. Jour.* xix. 153
θ_2 Orionis	...	...	5·3		
σ Orionis	5 34	− 2 39	3·8	,,	,, ,,
ξ Orionis	6 6	+14 14	4·4	,,	Frost and Adams, *Astroph. Jour.* xix. 154
S Monocerotis	6 36	+ 9 59	4·6	,,	,, ,,
α_2 Geminorum (Castor, bright)	7 28	+32 7	...	Lick	Campbell, *Pub. Ast. Soc. Pac.* xvi. 260
η Hydræ	8 38	+ 3 46	4·3	Yerkes	Frost and Adams, *Astroph. Jour.* xix. 155
α Libræ	14 45	−15 37	2·3	Lowell	Slipher, *Astroph. Jour.* xx. 147
σ Scorpii	16 15	−25 21	3·0	,,	,, ,,
X Sagittarii	17 41	−27 48	4·9	,,	,, ,,
W Sagittarii	17 59	−29 35	4·8–5·8	Lick	Curtiss, *Astroph. Jour.* xx. 172
Y Sagittarii	18 15	−18 54	5·8–6·6	,,	Curtiss, *Astroph. Jour.* xx. 231
S Sagittæ	19 51	+16 22	5·6–6·4	,,	,, ,,
τ Vulpeculæ	20 47	+27 53	5·5–6·5	Yerkes	Frost, *Astroph. Jour.* xx. 296
ε Capricorni	21 31	−19 54	4·5	Lowell	Slipher, *Astroph. Jour.* xx. 148

Professor Frost and Mr. Adams (*Astroph. Jour.* xix. p. 356) point out that their measures of the velocity of γ *Corvi* (publica-

tions Yerkes Obs. II. 226) were made at times when the variable nature of it discovered by Campbell and Curtis (*Astroph. Jour.* xviii. 307) could not be inferred.

Dr. Vogel (*Astroph. Jour.* xix. 360) contributes a very interesting paper on β *Aurigæ*.

	d
Pickering (*Sid. Mess.* 1891) gave the period of this spectroscopic binary as	3·9838
Rambaut (*Monthly Notices* R.A.S. li. 327) deduced from the same observations a period	3·968
Miss Maury (*Astroph. Jour.* viii. 171) in relating observations made in 1889–1898 gave a period ...	3·9838
Vogel finds from Potsdam observations a period ...	3·9599

which also fits Tikhoff's measurements of spectrograms obtained by Belopolsky at Pulkowa. With this period all the anomalies which Tikhoff found, and which led him to imagine that the system of β *Aurigæ* was highly complicated, disappear.

Orbits and Parallax of Spectroscopic Binaries.—

The orbit of ι *Pegasi* (period $10^{d}\cdot2$) has been worked out by H. D. Curtis (*Astroph. Jour.* xix. 212) based on forty-three photographs; range of velocity $+43$ to -52 km/sec.

The parallax of α *Centauri* (period $81^{y}\cdot2$) has been deduced by W. H. Wright and Dr. Palmer (*Astroph. Jour.* xx. 141) from three photographs of each component of the pair on the assumption that the observed difference of velocity (5·17 km/sec) is due to relative orbital motion at the epoch of observation, and can be wholly accounted for by Roberts's orbit of the pair.

An approximation to the orbit of *W Sagittarii* (period $7^{d}\cdot6$) has been got, partly by graphical methods, by R. H. Curtiss (*Astroph. Jour.* xx. 172).

The orbit of δ *Orionis* (period $5^{d}\cdot73$) has been determined by Professor J. Hartmann (*Astroph. Jour.* xix. 268) from forty-two photographs of the spectrum; range of velocity $+133$ to -67 km/sec. Deslandres had deduced a period $1^{d}\cdot92$ from his observations 1900. Hartmann shows that a period three times as long satisfies all the observations well. He also notes the fact that the calcium line K does not indicate any variability of velocity (see also Deslandres, *Ast. Nach.* **166**, 33).

Measurement and Reduction of Observations.—Dr. Hartmann (*Astroph. Jour.* xx. 338) describes an ingenious simplification in measuring and reducing spectrograms in the determination of radial velocities, avoiding all need to measure, record, and identify individual lines in spectra. The method is one that seems capable of extended application to measurement of many kinds of photographs.

Mr. R. H. Curtiss (*Astroph. Jour.* xx. 338) gives in detail a method which he has used at the Lick Observatory.

Miss Dobbin (*Astroph. Jour.* xix. 382) publishes a table of line of sight constants for 112 stars of the *Orion* type in the same form as Schlesinger's table (*Astroph. Jour.* x. 1).

Discussion of Standards of Wave-length.—The following papers relating to discussion of systems of wave-lengths have appeared :—

Messrs. Fabry and Perot	*Astroph. Jour.*	xix. 119 and xx. 318
Professor Kayser ...	„	xix. 157 „ xx. 327
„ Crew ...	„	xx. 313
„ Hartmann ...	„	xx. 41
Mr. Jewell	„	xxi. 1

New Spectrographic Installations.—Mr. Slipher (*Astroph. Jour.* xx. 1) gives an illustrated account of the spectrograph mounted in 1901 on the 24-inch refractor of the Lowell Observatory. It is being carefully used, for planetary observations in particular. The reproductions of photographs of the spectrum of *Jupiter* (*loc. cit.* Plate III.) and of *Neptune* and *Uranus* (*Lowell Obs. Bull.* No. 13) show great promise.

Professor Küstner (*Ast. Nach.* **166**, 177) began spectrographic work in the summer of 1903 with a three-prism spectrograph attached to the Bonn photographic refractor, 30 cm. (12 inches) aperture.

Mr. W. H. Wright (*Astroph. Jour.* xx. 140) reports the successful installation of the Mills expedition on the summit of Cerro San Cristobal at Santiago. With a three-prism spectrograph attached to a 94 cm. (30·7 inches) Cassegrain reflector he has detected variable radial velocity in five stars and a difference in velocity between the components of *α Centauri.*

Mr. Horace Darwin (*Astroph. Jour.* xx. 347) gives a brief description of an electric thermostat designed for the spectrograph attached to the 24-inch refractor at the Royal Observatory, Cape of Good Hope (see also *Proc. Phys. Soc. Lond.* xix. 64).

Loss of Light in Stellar Spectroscopes.—Mr. J. H. Moore (*Astroph. Jour.* xx. 285) has carried out investigations, suggested by Professor Campbell, relating to the loss of light by diffraction at a narrow slit. This paper is followed by another relating to loss of light by absorption and reflection in the 36-inch Lick objective.

H. F. N.

International Co-operation in Solar Research.

In the early part of 1904 Professor Hale drew attention to the advantages which might result from arranging some plan of co-operation among those engaged in solar investigations. At a time of sun-spot maximum in particular it is desirable that the Sun should be under almost constant observation. The subject covers a wide range, and is of a diversified character, including the observation of widened lines, photographs, and spectroheliographs. It is clear that to secure a continuous record of the spot phenomena, observations of the widened lines of all spots in a

considerable extent of the spectrum, and continuous records by the spectroheliograph in the H and K lines and the lines of hydrogen, a very extensive scheme of co-operation will be necessary. The American Academy of Sciences, which had appointed a Committee of Solar Research, with Professor Hale as chairman, called together a conference at St. Louis on 1904 September 23. Delegates were sent from the astronomical and physical societies of Europe and America, the Royal Society and the Royal Astronomical Society being represented by Professor Turner. The conference passed a resolution "in favour of the organisation of a scheme of international co-operation in solar research which shall encourage individual initiative, provide suggestions for definite lines of work, and facilitate the collection of results for publication." A committee was appointed for the purpose of obtaining the support of the International Association of Academies. An international committee, consisting of one delegate from each of the participating societies, was appointed and authorised to invite at its discretion other societies and individuals to co-operate. A discussion took place on the formation of a provisional programme of observations, and at the conclusion a committee, consisting of Professors Hale, Schuster, and Arrhenius, was nominated to draw up such a programme.

The question of standards of wave-length and the advisability of revising Rowland's standards was discussed, and several memoirs presented which were referred to the International Committee. Owing to lack of time the question of the observation of solar eclipses was similarly referred.

Oxford and Meudon were suggested as places for the next meeting.

New Observatory at Mount Wilson.

For the purpose of making special investigations on the Sun a new observatory has been established under Professor Hale's direction at a height of 5886 feet on the summit of Mount Wilson, near Pasadena, California, U.S.A. The Observatory was erected by the aid of a grant from the Carnegie Institution, and is referred to in the *Astrophysical Journal* as an expedition from the Yerkes Observatory. There seems to be every prospect that the Observatory on Mount Wilson will be permanent; and from the presence of Professor Barnard and Mr. Ritchey it may be inferred that the observations will not be confined to solar research.

The principal instrument at present is the Snow horizontal telescope, constructed in the optical shops of the Yerkes Observatory: it consists of two plane mirrors—one of which is driven as a cœlostat—which feed one of two long focus mirrors. These mirrors are of 24 inches aperture and of 60 feet and 145 feet focal length respectively, and are used with powerful spectro-

heliographs and spectrographs for the study of sun-spots and other solar phenomena.

The present staff of the Observatory consists of the Director (Professor Hale), with Mr. Ellerman and Mr. Adams, who are associated with him in solar and spectroscopic researches; Mr. Ritchey, who is in charge of the workshop and optical experiments; and Professor Barnard, who has taken to Mount Wilson the large doublet lens presented to him by Miss Bruce. The optical work conducted under Mr. Ritchey's supervision includes the fusing of quartz with a view to the possibility of making mirrors from it. It is hoped that the five-foot telescope constructed by Mr. Ritchey will be mounted on the summit; but this will involve in the first instance the widening of the trail up the mountain, which is at present too narrow to allow of the transport of the parts of the instrument. The conditions of residence at the new Observatory will be somewhat novel: the wives and families of the observers will reside in Pasadena, the observers themselves occupying "monastic" quarters on the summit while at work, and descending for brief week-end visits.

Note added later.—The Observatory has now been definitely placed under the Carnegie Institution, and is named the "Solar Observatory," Mount Wilson, California. All letters should be addressed to "Observatory Office," Pasadena, California.

The Astrographic Chart and Catalogue.

A footnote in last year's report (see *Monthly Notices*, vol. lxiv. p. 374) stated that four fascicules of the Astrographic Catalogue had been received from the Algiers Observatory. These, with four fascicules from the Toulouse Observatory and a volume containing the measured rectilinear co-ordinates of the stars on half the plates of the Greenwich zone, *i.e.* the plates which cover the zone of declination from 64° N. to 72° N., form the total of the results of the work published last year.

The publications of the French observatories are similar in form and in most of their details to the volume previously published by the Paris Observatory. Essential points in which the English catalogue differs from the French arise from the fact that at Greenwich two plates, or rather portions of two plates, which cover the same area of the sky are measured together in the "duplex" micrometer, and hence each plate is measured only as far as the lines in which it intersects the adjacent plates whose centres have the same declination, or differ from it by two degrees, north and south, whereas all the stars on each of the plates taken at the French observatories are measured. As a result of this the Greenwich catalogue contains two measured positions and only two of every star; but in the system in which each plate is measured separately and

entirely, the same star can occur four or even five times, and it appears in the printed catalogue each time with a different designation, for in this system the stars are numbered consecutively, beginning with unity, on each plate. In the English system each star is known by the number of the zone of declination in which it occurs and its number in that zone. With the duplex micrometer measurement is made by means of a scale in the eyepiece, divided into tenths and hundredths of a *réseau* interval (300″), and the co-ordinates in the Greenwich Catalogue are given in terms of a *réseau* interval to the fourth decimal. The French plates are measured by means of a micrometer screw, and the co-ordinates are given in millimètres also to the fourth decimal of the unit. In all cases the measured co-ordinates are given uncorrected for scale value or for orientation of the plate. In the Algiers Catalogue, as in the Greenwich, no correction for possible errors of the *réseau* have been applied, but tables of such errors, when they are sensible, and of plate constants are given with other information in all the catalogues sufficient to convert these simple measures into Right Ascension and Declination. The French volumes give the constants together with the places of the stars in equatorial co-ordinates from which they are deduced on the same page as the plate to which they refer—a convenient method to which the Greenwich arrangement of printing does not lend itself—but in this work these data are collected in the Introduction. M. Trépied's (Algiers) Introduction is very complete, and gives an exhaustive *résumé* of astrographic geometry. M. Baillaud (Toulouse), as introduction to Tome IV., gives a description of his method of determining the magnitude of the stars on photographs by means of a wedge photometer.

The measurement and reduction of the Oxford University Catalogue Plates is completed, and the printing of this zone waits only for the provision of the necessary funds. At the Cape of Good Hope Observatory 760 Catalogue plates have been measured containing over 440,000 stars, and the measurement is proceeding at Sydney and Melbourne. M. Valle's report for the year 1903 states that the reduction of the measures is in hand at Tacubaya.

The weak link in the chain appears to be in the zone of declination 17° S. to 40° S. originally allotted to three South American observatories; part of this has been undertaken by the Perth (W. Australia) Observatory, and Mr. Cooke reports that 874 Catalogue plates have been taken, but no provision has been made for measuring them. He adds that "if the State Government remains in its present mood with respect to astronomical work the only thing will be to prepare the Catalogue piecemeal. There is no likelihood of making any measures during 1905." Another section of this zone has been undertaken by the Argentine National Observatory. The progress of the work done here was reported in the *Monthly Notices* for June last.

During the year enlarged copies of the Chart Plates (40

minutes' exposure) have been made at the Royal Observatory, Greenwich, by a photographic process already described (*Monthly Notices*, vol. lxiii. p. 132), and copies of 136 fields in the zones 65°, 66°, 67° have been distributed during 1904 to fifty observatories and other institutions. Similar copies, but made by heliogravure process, continue to be distributed by the French observatories, and the numbers at present received are, Paris 207, Algiers 176, Toulouse 107. H. P. H.

Universal Time, Longitudes, and Geodesy.

From 1904 October 30 the time-ball at Hong Kong has been dropped by order of the Governor of the Colony at $17^h\ 0^m\ 0^s$ G.M.T., which is $23^m\ 18^s{\cdot}14$ in advance of $1^h\ 0^m\ 0^s$ of Hong Kong mean time. This announcement, which at first sight seems unimportant, is actually the final step in a movement which has resulted in the adoption as standard of the time of the zone eight hours east of Greenwich in Eastern China and in the British Colonies, Hong Kong, Labuan, and British North Borneo, which come within its limits. It is probable that the time of the seventh hourly meridian will be adopted in Western China, but the exact line of delimitation is not yet settled.

A new time system has been proposed for India, Further India, and Burmah. The scheme suggested is that the times of the meridians $5\frac{1}{2}$ and $6\frac{1}{2}$ hours east of Greenwich should be adopted in these territories. No reason is given why hourly meridians five hours and six hours east should not be chosen; a plan which would bring the time of India into harmony with that of almost the whole of the civilised world.

During the year the definitive result of the longitude Potsdam-Greenwich determined by Professor Albrecht and Dr. Wanach, of the Prussian Geodetic Institute, has been published. The difference of longitude between the meridian of the transit room at the Geodetic Institute at Potsdam and the transit circle at Greenwich was found to be $52^m\ 16^s{\cdot}051$, and the probable error of the determination $\pm 0^s{\cdot}003$. It will be remembered that in this work star transits were recorded by means of Repsold registering micrometers, and it is worthy of note that the difference of personal equation of the observers derived from the observations is $0^s{\cdot}000 \pm 0^s{\cdot}005$.

By help of the result of a determination of the arc Berlin-Paris made in 1877 by officers of the Institute, Professor Albrecht deduces a value of the arc Paris-Greenwich $9^m\ 20^s{\cdot}912$, or by using a value of the arc Berlin-Paris taken from *Bakhuyzen's Compensation* the difference between Paris and Greenwich arrived at is $9^m\ 20^s{\cdot}887$.

The results of the direct determinations of the arc Paris-Greenwich made in 1902 have also been published. The value

found by the French observers is $9^m\ 20^s{\cdot}974$, with a probable error of $\pm 0^s{\cdot}008$. The English result is $9^m\ 20^s{\cdot}932 \pm 0^s{\cdot}006$.*

Mention may be made here of the result of the work of the Russo-Swedish expedition to Spitzbergen to measure the length of an arc of the meridian in a northern latitude, a summary of which was published in the *Bulletin Astronomique* for 1904 June. One principal fact determined appears to be that the distance between the parallels of latitude of Keilhau and Thumb Point is

$$272072^{m}{\cdot}3 \pm 4^{m}{\cdot}6$$

	°	′	″
Latitude of Keilhau	76	37	$44{\cdot}6 \pm 0{\cdot}2$
Latitude of Thumb Point ...	79	3	$59{\cdot}1 \pm 0{\cdot}3$

In the calculations the ellipsoid of Bessel has been taken as base.

H. P. H.

* Since this has been in type, Professor Albrecht has combined the results of 176 telegraphic European longitude determinations among which these mentioned in this note are included to form a "Compensation." The definitive value for the arc Potsdam-Greenwich resulting from this is $52^m\ 16^s{\cdot}062$, that of the arc Paris-Greenwich is $9^m\ 20^s{\cdot}932$ (*Astronomische Nachrichten*, No. 3993-4, vol. 167, p. 157).